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Condition of Sugar Maple

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INTRODUCTION

During the late 1970s and throughout the 1980s sugarbush managers, foresters and the general public became concerned about maple decline. In response to these concerns, the North American Maple Project (NAMP) was formed in 1987 between Canada and the United States and authorized by a Memorandum Of Understanding and Special Project Agreement.

The administration and the financial support for the project is provided by the Canadian Forest Service and Forest Health Protection, Northeastern Area, USDA Forest Service. Participating states and provinces provide field crews and local administration of the project.

The current project is guided by a Joint Management Team co-chaired by Gerard D. Hertel, U.S. Forest Service, and J. Peter Hall, Canadian Forest Service. Ten states and four provinces cooperate in the project. National Coordinators provide day-to-day guidance: Bruce Pendrel, Canadian Forest Service, and Robert Cooke, U.S. Forest Service. Quality-assurance is a high priority because 14 different agencies collect data. Standardized training is provided by the National Coordinators annually. Remeasurements are done between crews, states and provinces for data quality evaluation by the National Coordinators. Data analysis is provided by Douglas C. Allen and Andrew W. Molloy, State University, College of Environmental Science and Forestry, Syracuse, New York.

OBJECTIVES

The objectives of the project are to determine:

1. the rate of change in sugar maple condition ratings.

2. if the rate of change in sugar maple condition ratings is different among:

   a. various levels of sulfate and nitrate wet deposition.

   b. sugarbush (SB) and non-sugarbush (NSB) forests.

   c. various levels of initial stand decline conditions.

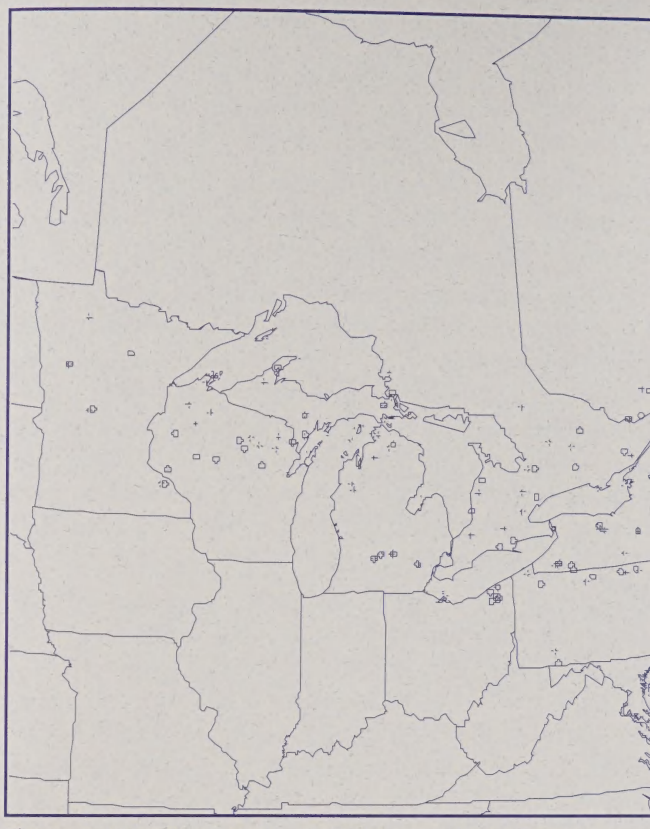


Figure 1. North American Maple Project plot-cluster locations.

3. possible causes of sugar maple decline and the geographical relationships between potential causes and extent of decline.

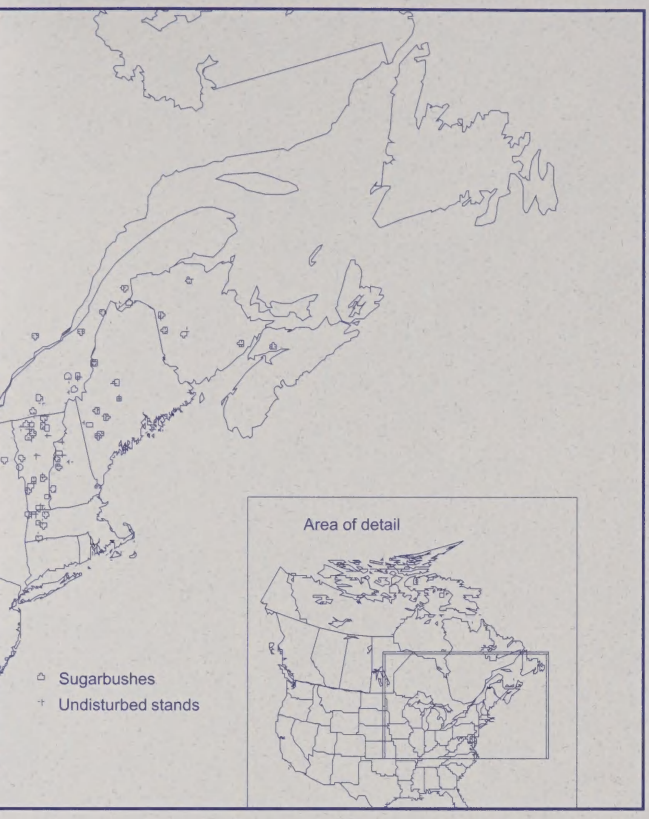
PLOT ESTABLISHMENT

The total number of plot-clusters (forest stands) monitored and evaluated by NAMP in 1997 was 230 (Table 1). Geographic coverage extends from Minnesota and Ontario, south to Ohio and Pennsylvania, and east to Nova Scotia (Fig. 1).

Each plot-cluster consists of five plots (20 by 20 m) located in a sugar maple stand that is 50 to 150 years old. In most

United States				Canada	
Maine	18	New York	27	New Brunswick	10
Massachusetts	10	Ohio	6	Nova Scotia	2
Michigan	23	Pennsylvania	10	Ontario	24
Minnesota	8	Vermont	40	Quebec	24
New Hampshire	10	Wisconsin	18		

Table 1. Distribution of plot-clusters in the North American Maple Project by state and province - 1997.



states and all the provinces, one-half of the plot-clusters are active sugarbushes and one-half are in non-sugarbush stands. Stands were selected to represent a range of initial forest decline conditions and site conditions, and they cover most of the prime sugar maple growing areas.

STAND DESCRIPTION

In 1997 the average sugarbush in this study had 152 live trees per acre (374 trees/ha), 75% of which were sugar maple, and the average tree diameter at breast height (dbh) was 10.6 in (26.9 cm). The non-sugarbush stands averaged 186 live trees per acre (460 trees/ha), 69% of which were sugar maples, with a slightly smaller average dbh of 9.9 in (25.2 cm). Average basal areas were 116.9 ft^2/ac (26.8 m^2/ha) and 121.2 ft^2 (27.8 m^2/ha) in sugarbush and non-sugarbush stands, respectively.

Observations in 1997 were made on 19,180 live trees, of which 72% are sugar maples. Sixty-nine percent of the live sugar maples are in the dominant or codominant overtstory crown positions. The other most common species are American beech, basswood, red maple, ash, and yellow birch.

METHODS

Sugar maple crowns are evaluated annually for crown dieback and foliage transparency and visited twice annually to assess insect defoliation. Annual visits are required because the incidence of dieback and transparency are expected to fluctuate from year to year as a result of individual tree response to changes in weather and site conditions. Insect defoliation may occur in both spring and mid-summer, therefore two annual visits are required.

Quality and consistency of data are assured through annual training and certification of field crews. In 1997, 9% of trees measured were remeasured in a Quality Control program. Repeatiblity of measurements for dieback were 97%; transparency 92%.

The results presented here are based on analyses of the crown condition of 9,516 live overstory (dominant/codominant) sugar maples in 1997. Branch dieback in the upper crown is a disease symptom caused by various stresses. For this project, 5% dieback is considered normal; 6% to 15% percent indicates moderate damage; and more than 15% dieback indicates a high level of damage. Foliage transparency, a measure of crown density, is estimated by the amount of light penetrating the crown. A transparency of 25% or less is considered normal for sugar maple, 26% to 55% transparency indicates a moderately thin crown, and greater than 55% transparency is considered high. The latter suggests that a tree is severely stressed.

	Average Dieback (%)		Average Transparency (%)	
Region	Sugarbush	Non-sugarbush	Sugarbush	Non-sugarbush
Maine	6.9	4.9	11.4	10.9
Massachusetts	5.9	6.0	11.9	10.6
Michigan	5.4	5.9	9.5	9.4
Minnesota	7.3	7.4	9.6	9.9
New Brunswick/ Nova Scotia	8.4	7.1	9.4	8.6
New Hampshire	4.0	2.8	12.1	11.1
New York	8.6	6.2	10.3	10.7
Ohio	7.6	-	9.3	-
Ontario	5.8	6.0	11.7	12.5
Pennsylvania	5.9	6.5	20.8	20.7
Quebec	9.2	8.2	11.7	11.6
Vermont	7.2	6.6	12.4	12.0
Wisconsin	4.9	4.9	15.5	16.3
All	**6.9**	**6.2**	**11.9**	**11.8**

Table 2. Average plot-cluster dieback (%) and transparency (%) of overstory sugar maples, 1997.

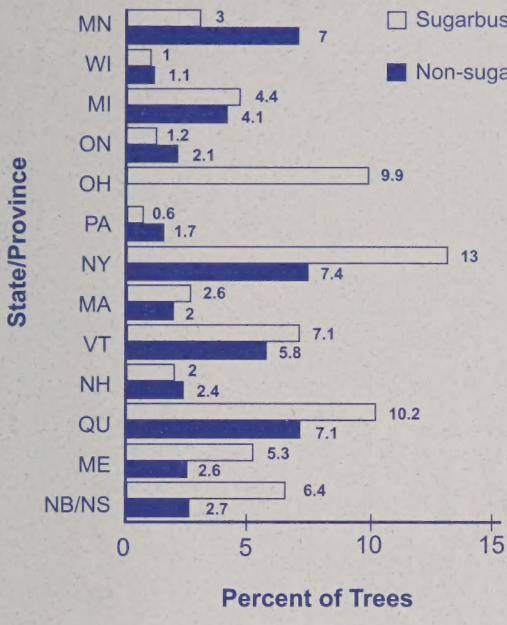


Figure 2. Percent of overstory sugar maples with >15% dieback in 1997.

SUGAR MAPLE CONDITIONS IN 1997

Dieback

Crown dieback reflects the general, long-term health of individual trees. The average dieback of overstory sugar maples in 1997 for all 230 plot-clusters was 6.9% in sugarbushes and 6.2% in non-sugarbushes (Table 2). Over 10 years this average changed by less than 2% for both categories. The highest crown dieback for 1997 was in Quebec where sugarbushes averaged 9.2% and non-sugarbushes, 8.2%. Average dieback was greater in sugarbushes compared to non-sugarbushes in 6 of 12 regions in 1997. The range of differences was 0% to 2.4%, and none were statistically significant. During the past ten years (1988-1997), four regions had statistically higher dieback in sugarbushes compared to non-sugarbushes; however, all differences were 2% or less.

Figure 2 compares the incidence of high levels of dieback (>15%) between regions using all overstory sugar maples in 1997. New York had the greatest percentage of trees with >15% dieback in sugarbushes and non-sugarbushes (13% and 7.4%, respectively). In many regions, minor changes occurred in the proportion of overstory sugar maples with >15% crown dieback compared to the previous year. These changes may reflect normal fluctuations in

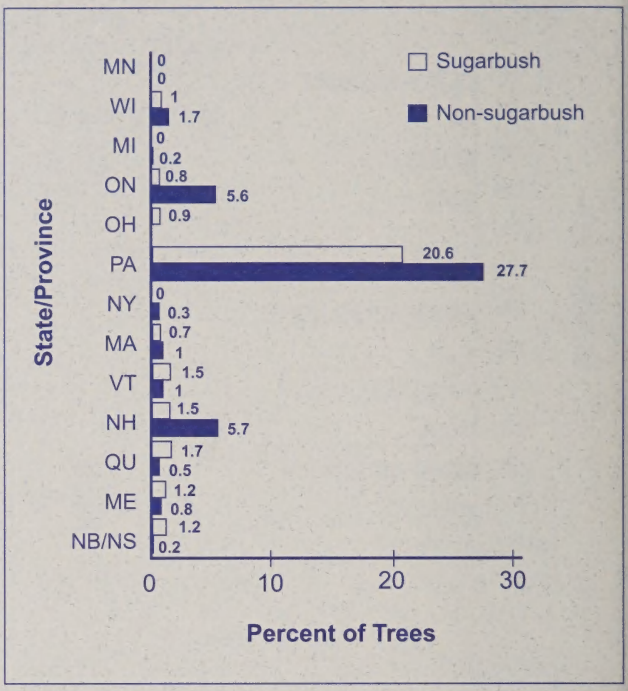


Figure 3. Percent of overstory sugar maples with >25% transparency in 1997.

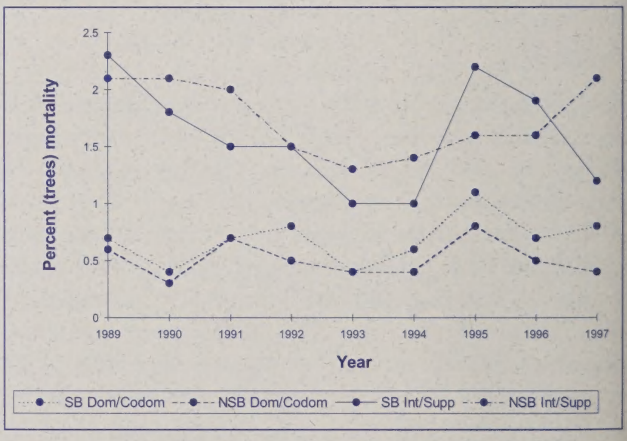


Figure 4. Percent (trees) mortality for sugar maple (1989-1997).

crown condition. Quebec displayed one of the largest increases from 1996 to 1997 (3.4% and 4.1% for sugarbushes and non-sugarbushes, respectively). The largest change from 1996 to 1997 occurred in Wisconsin. This 14-15% decrease in the number of trees with high dieback in both management categories reversed an increasing trend in 1995 and 1996.

State/Province	Live trees in 1997	Sugarbus Mortality (%
Maine	669	0.3
Massachusetts	428	0.0
Michigan	164	0.0
Minnesota	215	0.0
New Brunswick/Nova Scotia	812	0.4
New Hampshire	241	0.7
New York	506	1.6
Ohio	134	1.5
Ontario	871	0.9
Pennsylvania	169	0.0
Quebec	1,187	1.6
Vermont	923	0.9
Wisconsin	598	0.7
ALL COMBINED	**6,917**	**0.6**

Table 3. Mortality of overstory sugar maples (% trees) in NAMP by st (note: averages for MN, OH and PA based on five years).

Transparency

Crown transparency reflects annual fluctuations in tree condition due to disturbances such as defoliation and drought. The average plot-cluster transparency of overstory sugar maples in 1997 was 11.9% in sugarbushes and 11.8% in non-sugarbushes (Table 2). These averages have been fairly consistent since 1990 and are lower than the 1988 and 1989 averages. Average plot-cluster transparency has decreased (improved) by 5.9% and 4.3% in sugarbushes and non-sugarbushes, respectively, since 1988. The highest average transparency in 1997 occurred in Pennsylvania (21%). No disturbances were recorded for Pennsylvania plot-clusters which might explain the appearance of these relatively thin crowns. Most regional averages declined from 1996 to 1997. Average transparency was greater in sugarbushes compared to non-sugarbushes in 8 of 12 regions in 1997, although none of the differences were statistically significant. Over ten years of monitoring, three regions showed a statistically higher transparency in sugarbushes vs. non-sugarbushes of up to 2%.

All but one state/province had less than 6% of its trees with >25% transparency (Fig. 3). In Pennsylvania over 20% of trees had >25% transparency in sugarbushes and non-sugarbushes. No defoliators or other disturbances were recorded in Pennsylvania plot-clusters in 1997, and it is unclear at this point what is responsible for this increase.

h %)	Non-sugarbush Mortality (%)	Combined Mortality (%) 1997	9-yr. avg.
	0.3	0.3	0.7
	0.5	0.2	0.3
	0.0	0.0	0.5
	0.0	0.0	0.5
	1.7	0.9	0.4
	0.9	0.8	0.6
	0.8	1.1	1.2
	-	1.5	0.9
	0.2	0.6	0.4
	0.0	0.0	0.4
	0.2	0.8	0.8
	0.0	0.4	0.6
	0.3	0.5	0.3
	0.4	**0.5**	**0.5**

ate/province and management type in 1997 and the nine-year average

Mortality

The ten-year NAMP data set enables us to determine the annual mortality rate (expressed as a percentage of trees) of sugar maple in the original 165 NAMP plot-clusters. This mortality does not include trees that were healthy when cut or whose death was the direct result of forest management practices, such as road building or skidding.

For seven of nine years, annual mortality of overstory sugar maples in sugarbushes was slightly higher than in non-sugarbushes by as much as 0.4% (Fig. 4). Annual mortality ranged from 0.3% to 1.1% in overstory trees and from 1.0% to 2.3% in understory trees. Sugar maples in understory positions are expected to have higher mortality due to competition. Mortality of overstory trees changed little from 1996 to 1997.

On a state/province level, mortality in sugarbushes in 1997 was higher compared to non-sugarbushes in 5 of 10 regions and somewhat higher overall (0.6% vs. 0.4%) (Table 3). New York and Quebec had the highest sugarbush mortality (1.6%) and New Brunswick/Nova Scotia had the highest non-sugarbush mortality (1.7%). These results are consistent with those reported in other studies.